EAMA11
Dec. 9-12, 2025

Collaboration in East Asia and Beyond

Overview of National Astronomical Observatory of Japan (NAOJ) and prospects for future

Mamoru Doi
Director General
National Astronomical Observatory of Japan, NAOJ



Toki Messe, Niigata, Japan

NAOJ



Founded in 1988

← Tokyo Astronomical Observatory, U.Tokyo(1888)
Mizusawa Latitude Observatory (1899)
…

→Institute of Astronomy, School of Sci., U.Tokyo(1988-)

~500 employee (Mitaka HQ ~300) permanent positions: researchers ~80 engineers ~40
Annual budget ~13b JPY

NINS(Natural Institutes of Natural Sciences) 2004-

NAOJ	NIFS	NIBB	NIPS	IMS
National Astronomical Observatory of Japan	National Institute for Fusion Science	National Institute for Basic Biology	National Institute for Physiological Sciences	Institute for Molecular Science

One of Inter-University Research Institutes

Our Mission:

- To develop and construct *large-scale cutting-edge astronomical research facilities* and promote their open access aiming to expand our intellectual horizons
- To contribute to the development of astronomy as a *world leading research institute* by making the best use of a wide variety of large-scale facilities.
- To bring benefits to society through astronomy public outreach.

NAOJ facilities

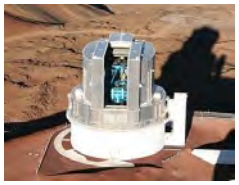
National Astronomical Observatory of Japan

ALMA, ASTE,
Atacama (radio)





Subaru 8.2-m, [TMT 30-m]
Hawaii (opt-IR)



Nobeyama 45-m (radio)



Yamaguchi VLBI (radio)



Mizusawa VLBI (radio)



Ishigakijima VLBI (radio)



KAGRA



Ibaraki VLBI (radio)



Iriki VLBI (radio)



Murikabushi 1-m
(opt-IR)



Mitaka HQ



Ogasawara VLBI (radio)





Seimei 3.8-m
(opt-IR)

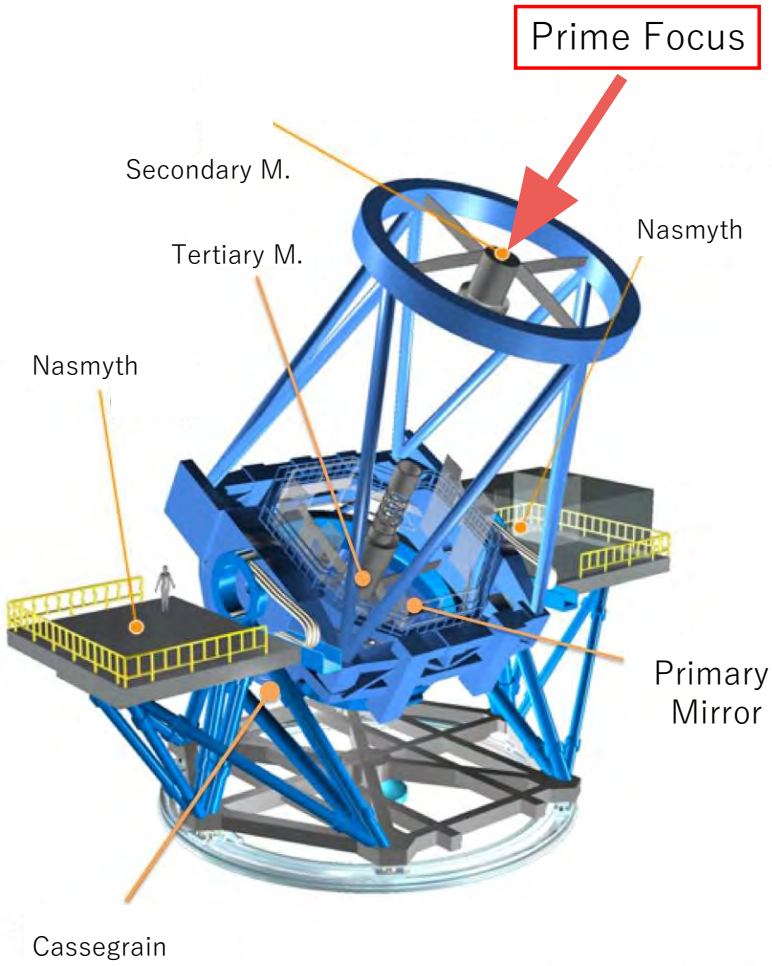




Ground-based telescopes all over Japan, in Chile and in Hawaii
Gravitational Wave Telescope KAGRA with ICRR/UTokyo&KEK,
Seimei 3.8-m telescope with Kyoto Univ.

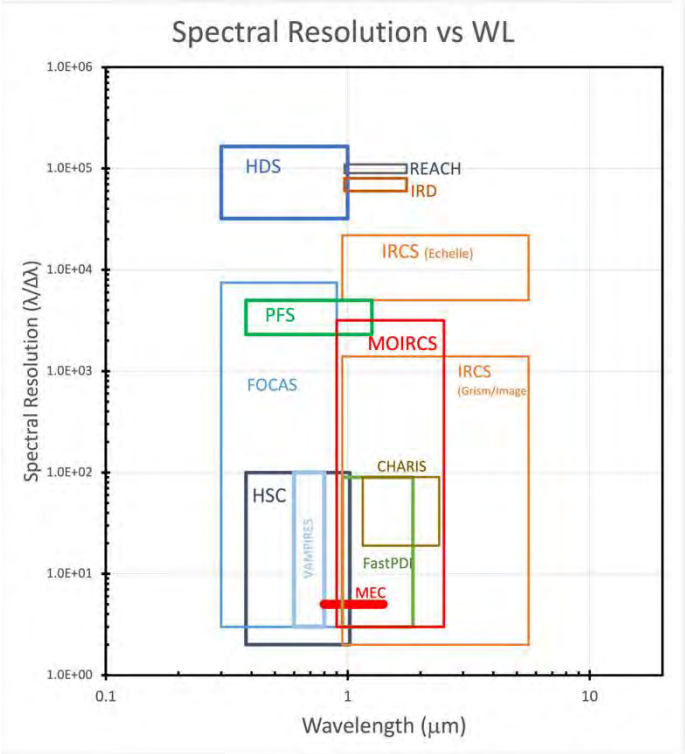
The Subaru telescope
(8.2m OptIR telescope in Hawaii) 1999-

Short focal length ⇒ Wide Field

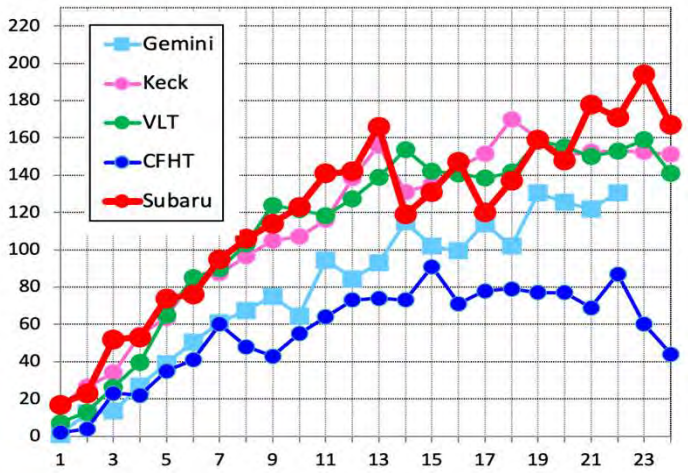


(c) META Corporation Japan #150132

Subaru Instrument Suite



Number of Publications/yr/telescope

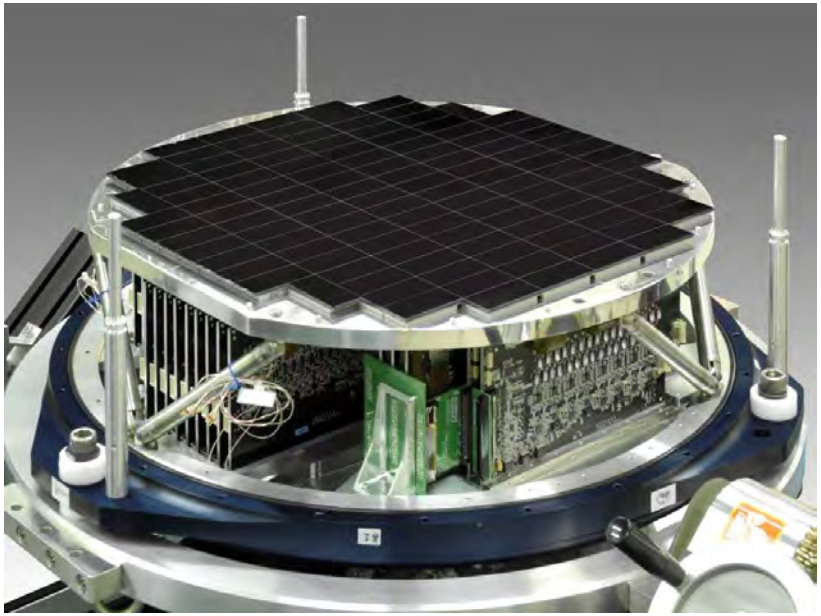


Years from Start of Operation

https://subarutelescope.org/Observing/Instruments/index.html

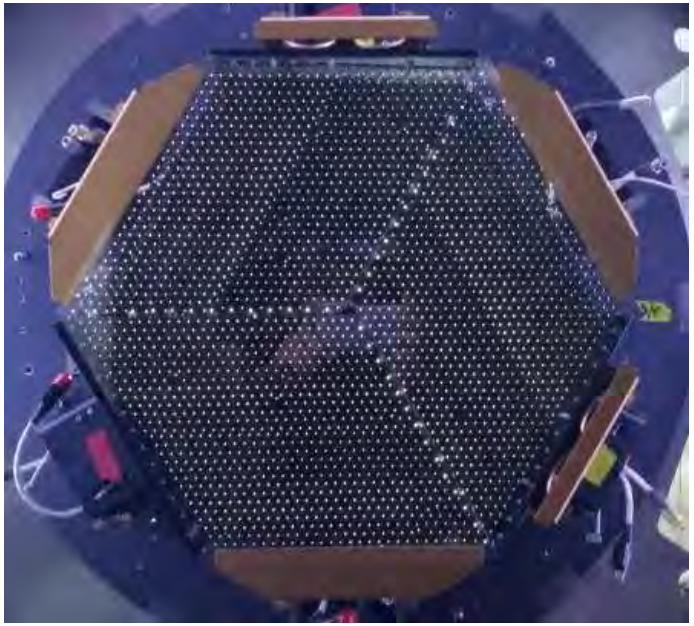
Uniquely featuring a wide field imager and spectrograph on the 8 m telescope

Hyper Suprime-Cam since 2014



50 cm diameter focal plane paved by 116 high-sensitivity CCD sensors developed jointly by NAOJ and Hamamatsu Photonics.

Prime Focus Spectrograph from 2025

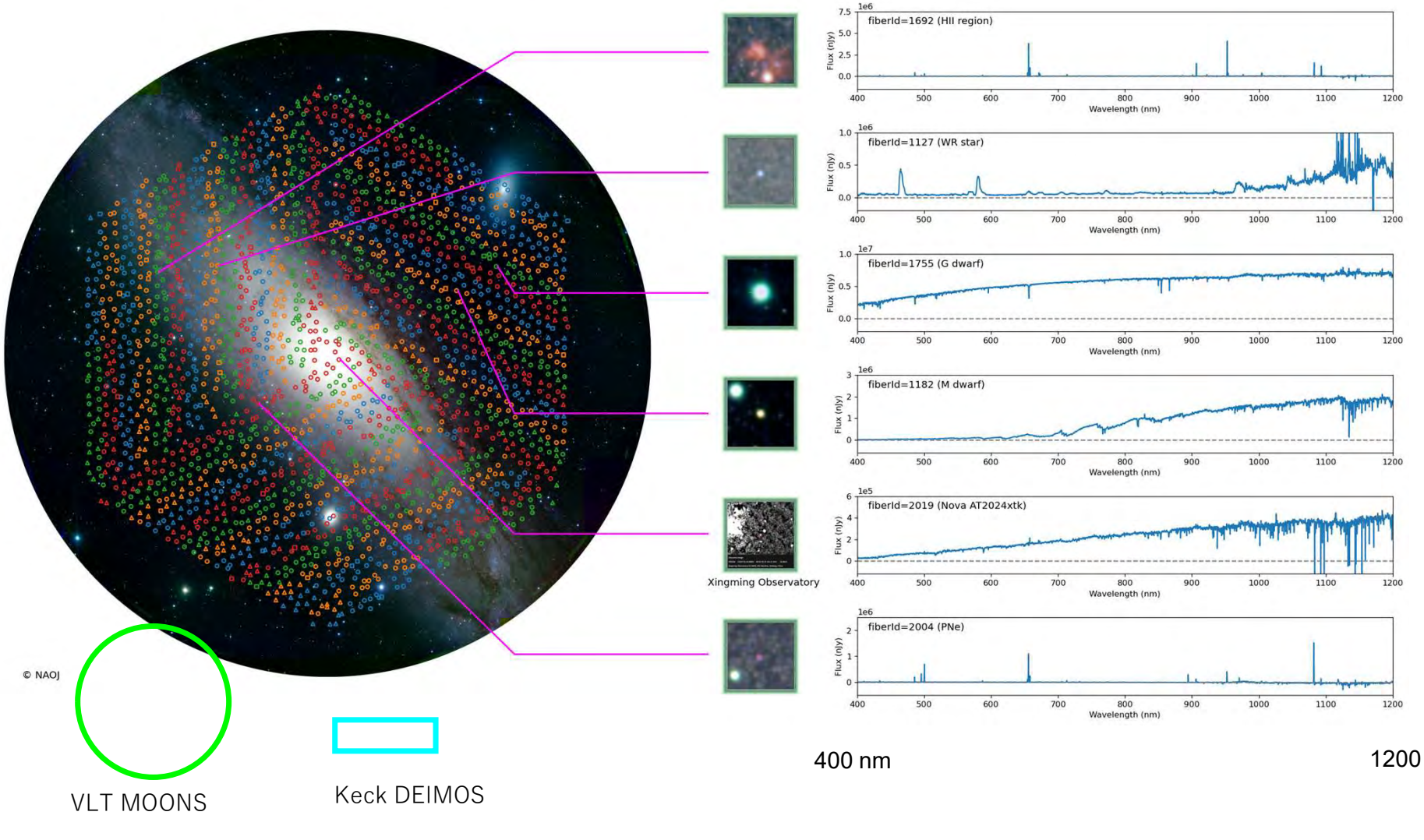


PFS is a fiber-fed multi-object (2400) spectrograph. Such multiplicity and field coverage (1.5 deg) is unique among 8-10 m telescopes.

Enabling Super “SDSS Survey”

⇒Takada CS-1l

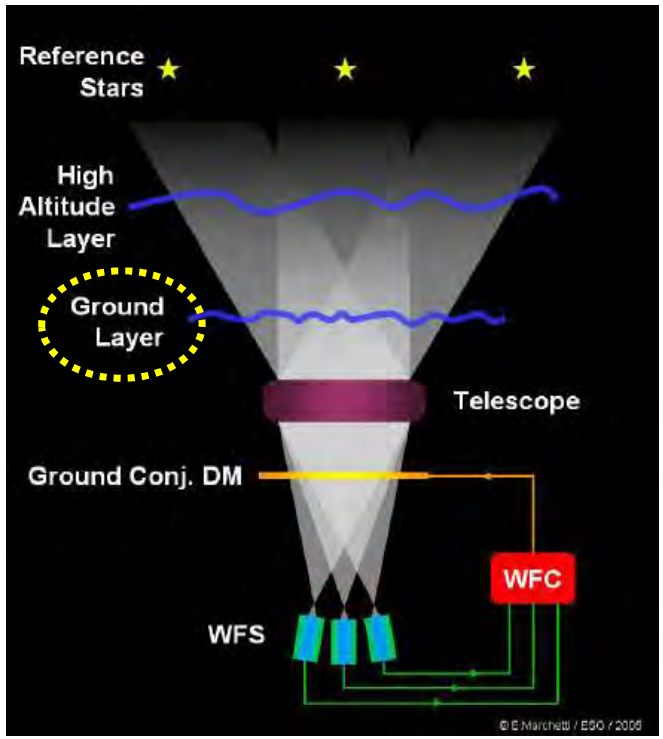
PFS started Science Operation in 2025/03

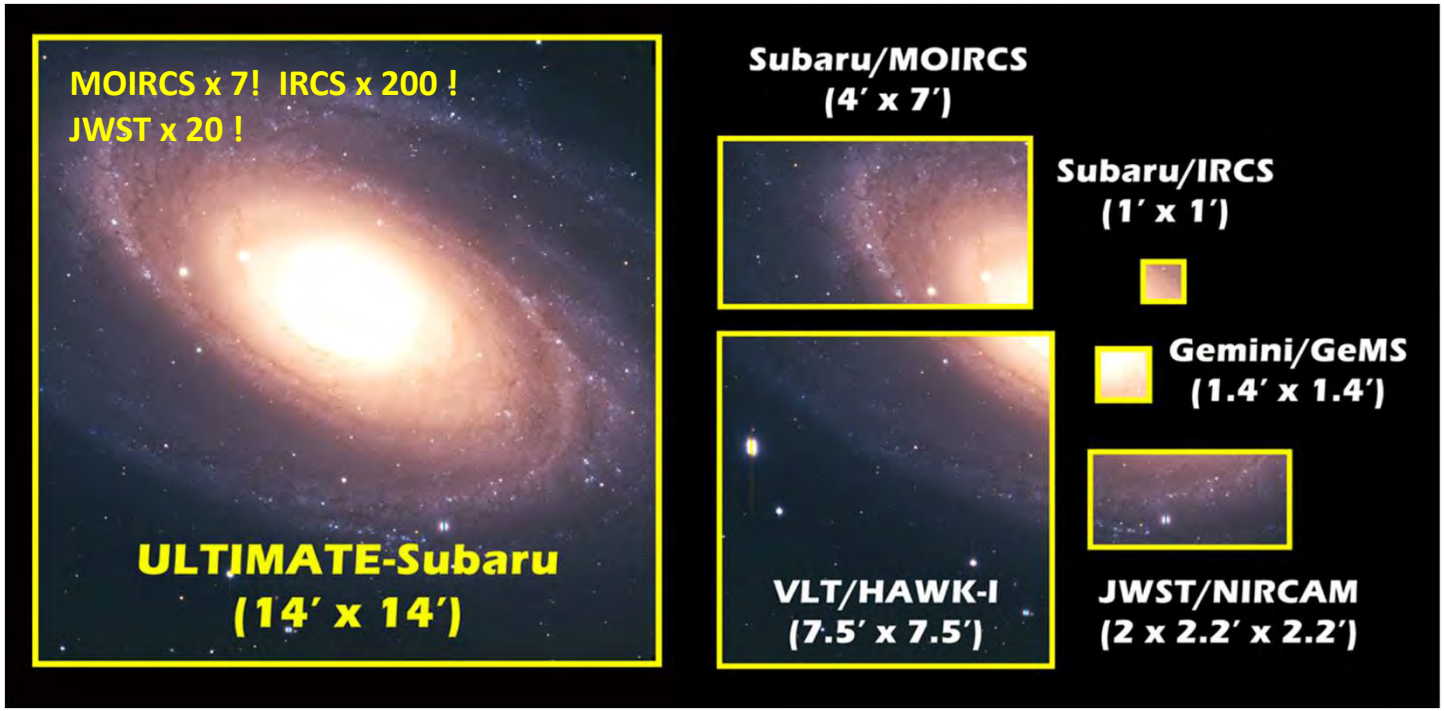


ULTIMATE-Subaru
すばる広視野補償光学プロジェクト

⇒Motohara PO-13P

- Wide-field adaptive optics system (**GLAO**) and wide-field IR imager (**WFI**).
- Improved image quality (**FWHM~0.2” in K-band**) over ~20-arcmin FoV.





Concept of Ground-Layer AO ©ESO

Overview of ALMA

⇒ Hatsukade, Izumi PR-15P, 17P

ALMA has a mission to search for our cosmic origins of life
in global partnership of 22 countries and regions

ALMA is an international project to construct and operate a large radio telescope in global partnership of East Asia, North America, and Member States of the ESO

※ in corporation with Republic of Chile (host country)

East Asia partnership:

- Japan: NINS/NAOJ
- South Korea: KASA/KASI
- Taiwan: ASIAA

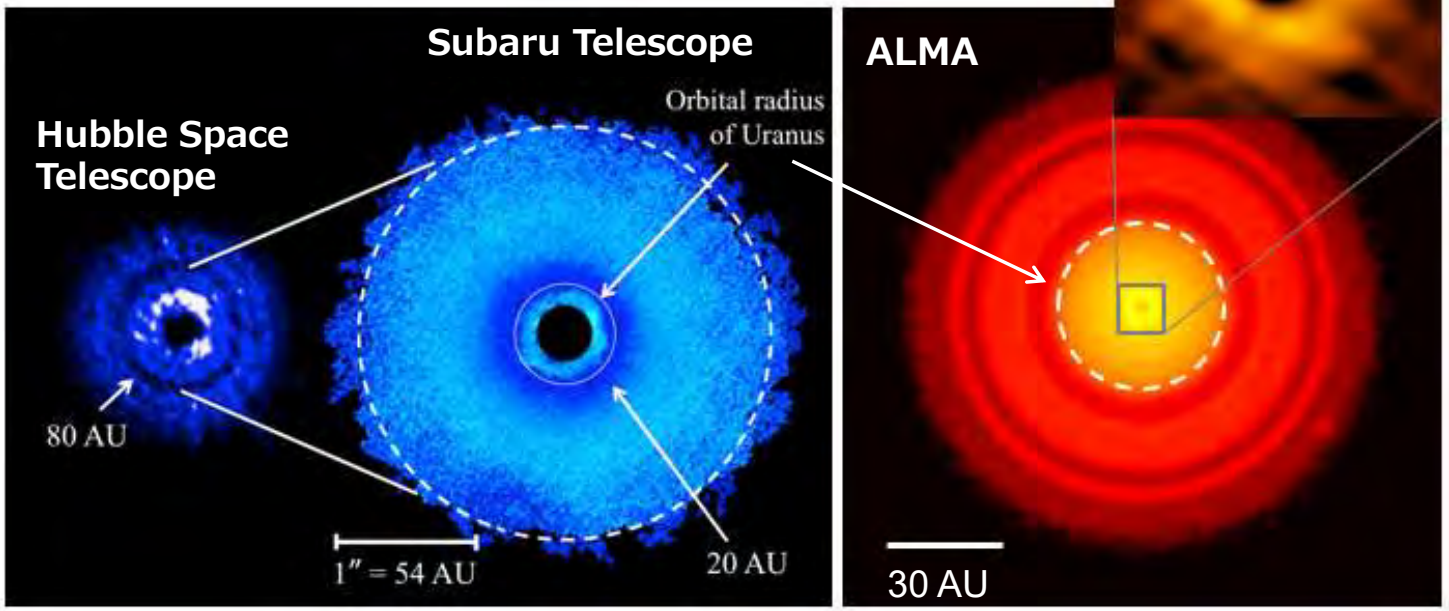


66 submm antennas on the high-altitude plateau in dry Atacama desert, Chile

Strong Cases of ALMA

ALMA is the best telescope to see the size of Earth's orbit in planet-forming regions around young stars.

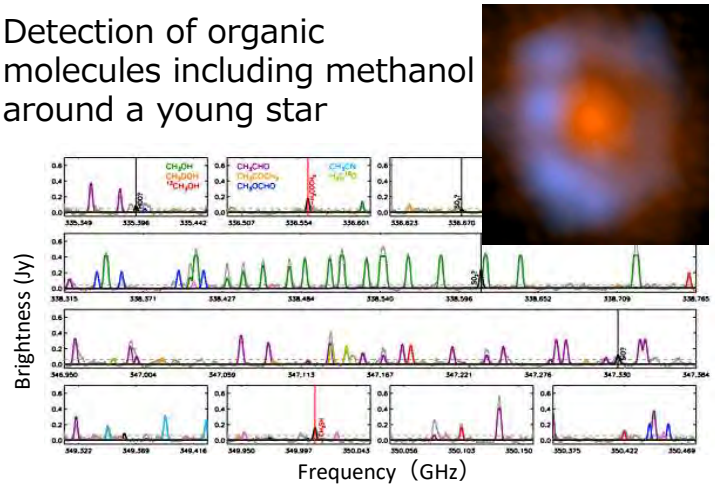
TW Hya at 175 light-years



~20 mas resolution for 16km baseline, 230GHz

ALMA reveals the chemical composition of various regions and makes significant progress in the detection of molecules that can be ingredients of life.

Detection of organic molecules including methanol around a young star



Lee et al. et al. *Nature Astronomy* 2019

Nobeyama Radio Observatory

⇒Nishimura PR-8P





- **Located north of Tokyo at an altitude of 1350 m.**
- **The observatory hosts the 45-m radio telescope since 1982.**
- **The 45-m telescope is one of the largest mm-wave single dish in the world**
  Large area mapping capability, Multi-lines: density, temperature, chemistry of cold gas, mm-wave VLBI
- **Easy to access**
  for development, for education

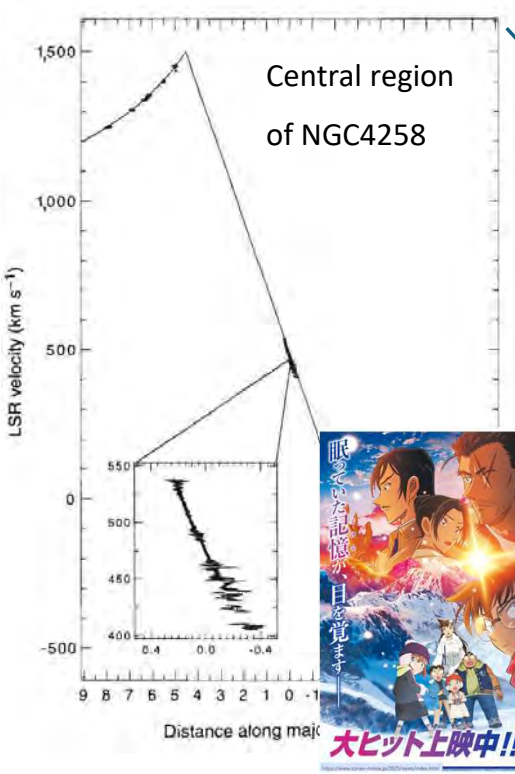
Nobeyama 45m Telescope Characteristics

Notable Outcome:
-High velocity H2O emission in NGC4258
-Discovery of new molecules
-CO(J=1-0) Galactic Plane Survey (Data public)

11 receiver ports are available

Frontend:	**FOREST (82-116 GHz, 4 beam)**
	eQ* (30-50 GHz, 1 beam)
	7BEE* (72-116 GHz, 7 beam)
	*** under commissioning**
Backend:	**SAM45 (2 GHz x 16 arrays)**
	RFSoC spectrometer (under development)

Charged telescope 33000JPY/hr
No scientific assessment, Remote Operation Possible



"a must-go place" for fans of "Detective Conan" movies

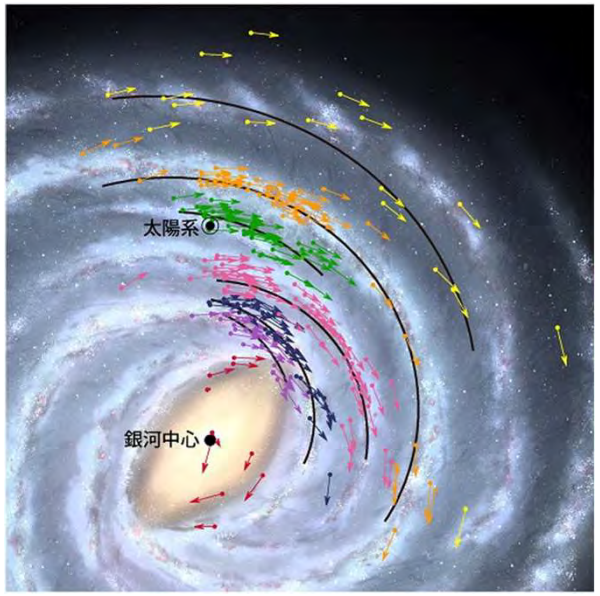
World largest mapping capability of ISM.

VERA & East Asian VLBI Network

VERA: VLBI array in Japan with four 20m dishes, 2-43 GHz







Galaxy's structure revealed by
VLBI astrometry (VERA, VLBA etc.)

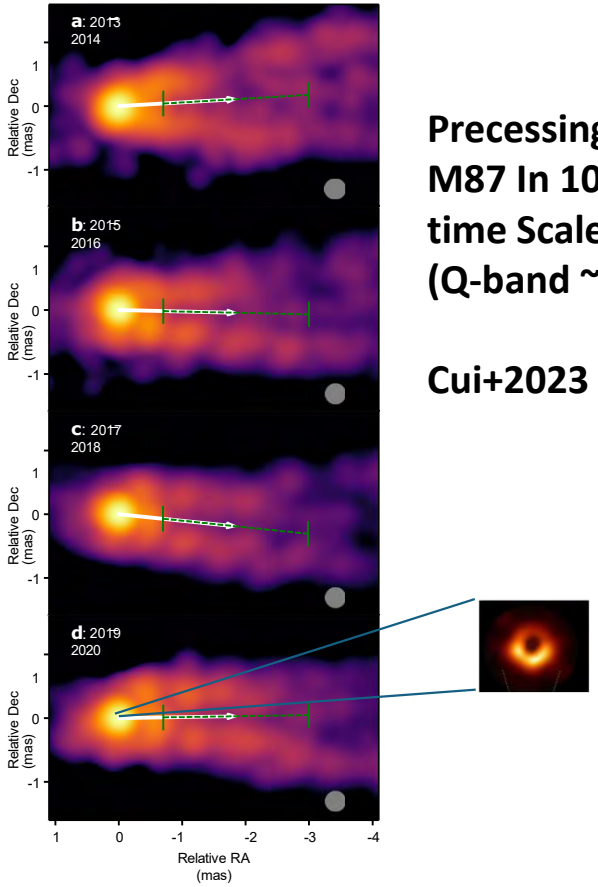
East Asian VLBI Network

EAVN: combined VLBI array by China, Korea, Thailand and Japan

(6 telescopes in Japan with Ibaraki Univ., Yamaguchi Univ., Kagoshima Univ.)

⇒Yonekura, Fujisawa PR-7P, 10P





Precessing jet of M87 In 10 years' time Scale (Q-band ~43GHz)

Cui+2023

National Astronomical Observatory of Japan

⇒Sakamoto PR-6P

Atacama Submillimeter Telescope Experiment

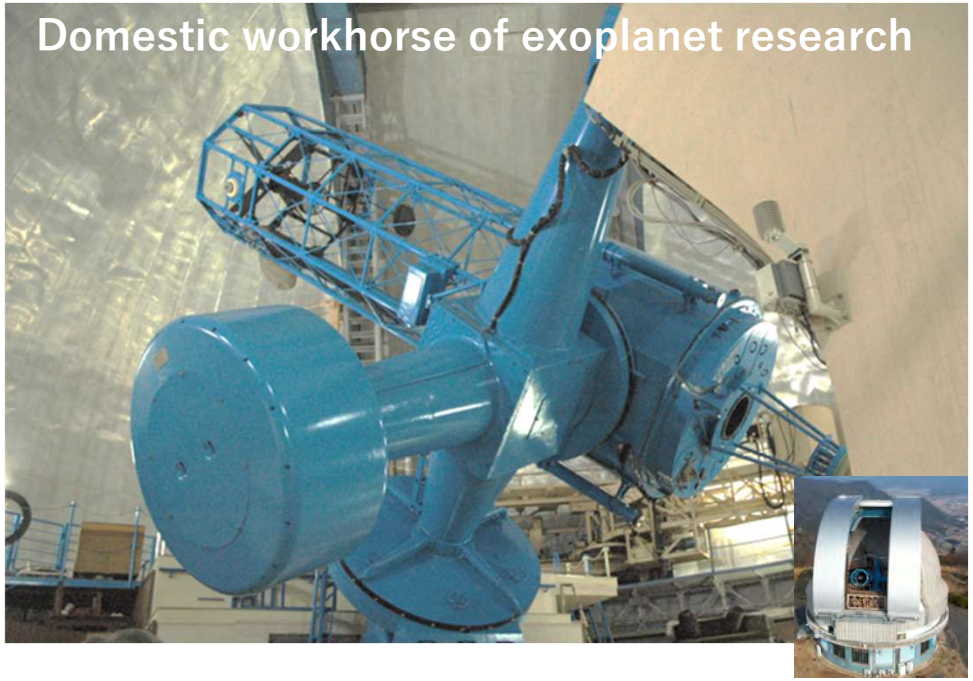
- 10-m submm telescope located at Pampa La Bola within the ALMA concession (2002-)
  - Surface accuracy: 19 μm →~45 μm COMING SOON **Deformation correction may be made**
  - Pointing accuracy: ~2″ (rms)
  - Receivers: DASH345 (321-376 GHz);
    Band8 → NEW **Wide-IF-bandwidth Band 8** (387-498 GHz, IFBW=16 GHz);
    Band10 (790-940 GHz)
  - Backend: WHSF → NEW **XFFTS**
  - Control and data reduction software:
    - COSMOS3, NEWSTAR/NOSTAR → NEW **CASA**
- Site infrastructure
  - Diesel generator (150 kW-220 V ×2)
  - Fuel tank (15 kL ×2, consumption 300 L/d)
  - Satellite network (1 Mbps)→ COMING SOON **FO (100 Mbps)**
  - Monitor (weather station, web cameras, etc.)



Altitude ~4800m

Okayama branch
188-cm Telescope

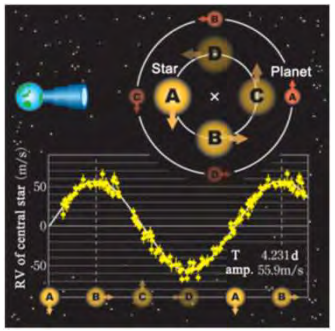
国立天文台 NAOJ + 東京工業大学 Tokyo Institute of Technology + ASAKUCHI CITY 天文のまち 浅口市 + User group



- Built in 1960.
- Operating through an agreement between NAOJ / Tokyo Tech (Science Tokyo) / Asakuchi-city).
- Based on the **fees paid by telescope users**.
  ➡ electrical charges, maintenance etc.

No operation costs covered by NAOJ budget

Not Open Use

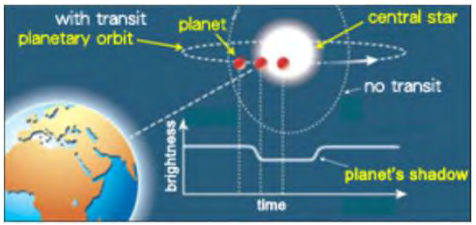


Doppler search w/HIDES-F

- From early 2000s, **more than 50 planets** have been discovered using I2-cell technique for the high dispersion echelle spectrograph (HIDES, -F).
- The planets discovered account for 30% of the world's discoveries in G, K-type giant stars.
- Extension planned to smaller and farther planets for searching solar-system analogues.

Transit measurement with MuSCAT

- **Photometry accuracy of ~0.2mmag**
- A worldwide network built with 4 identical instruments for **24-hr continuous observation.**
- Follow-up of PLATO will be conducted.





Development base for New technologies "Astro-comb"

- **Joint development with AIST** since 2014.
- Expected RV measurement accuracy
  Several tens of cm/s (theoretical limit <10 cm/s)
  [Conversion of spectral image drift on the detector into RV]
- Improvement of the spectrograph for that high precision also on-going.
- The results be applied to **Subaru and TMT**.

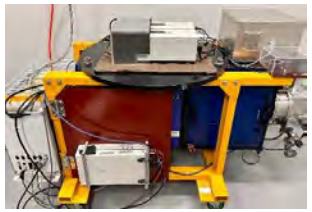
Kyoto Univ.
3.8-m Seimei Telescope



- Lightweight & High-speed (~4 deg/sec)
- Segmented primary mirror (18 segments)
- Operating from 2019 in collaboration w/NAOJ
- NAOJ covers the 1/2 operation costs as telescope time fee
- 50% Open use by NAOJ, 50% Kyoto univ. time
- **Full remote observation available** (since Jan. 2024)
- Queue & Automatic triggered ToO are under testing

KOOLS-IFU

Optical Low-dispersion Spectrograph with Integral Field Unit



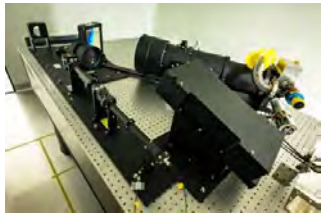
TriCCS

High-speed (max 98fps) Tricolor CMOS Camera and Spectrograph



GAOES-RV

High-dispersion Echelle Spectrograph for RV measurement（ΔRV～2m/s ）



Instrument change from one to another can be completed within a minute.
New instruments are also coming soon.

Key Science

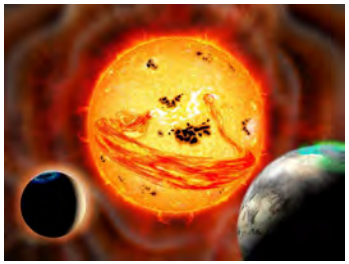
⇒Maehara AS-5C

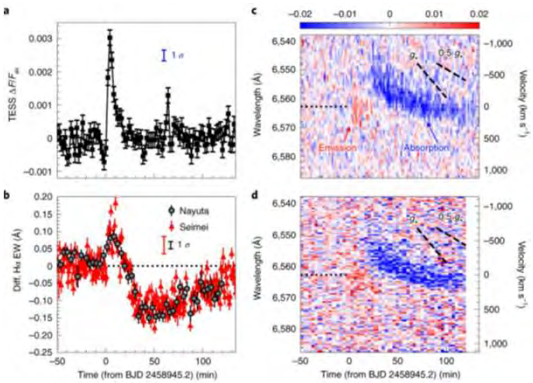
■Time-domain astronomy

Transient objects : Super novae, novae, GRBs, GW counterparts…

Monitoring obs. : Flare stars, Exoplanets …

ex.) First detection of an eruptive filament from a superflare on a solar-type star
Namekata+ 2021



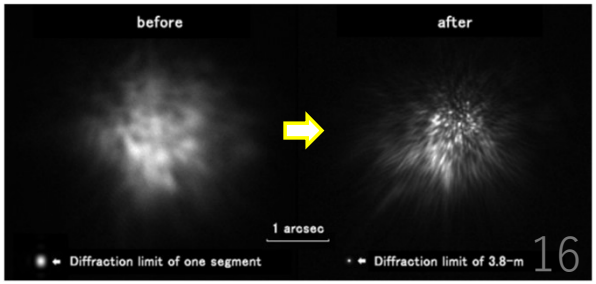


■Human resource development

■Instrument & Technology development

Succeeded for co-phase adjustment of the mirror segments to get speckle image (2024.7)

→ **AO w/segmented mirror**



more facilities



Super computer Aterui-III
by CfCA(Center for Computational Astrophysics)



TAMA300 Gravitational Wave telescope

→ KAGRA





→ Solar-C
2024-

Solar flare telescope (left) and Hinode satellite (right, with JAXA/ISAS)

Three “Centers” at NAOJ

⇒ Agata OE-9P



Astronomy Data Center
Data archive, analysis tools, PC resources



Advanced Technology Center
Development of optics, detectors, receivers etc.





Public Relation Center
Press release, outreach events, Managing web and publications to general public etc

OAO/IAU hosted by NAOJ

IAU Office for Astronomy Outreach

The Office for Astronomy Outreach (OAO) is the International Astronomical Union's central office for **global public engagement in astronomy.** Hosted by the National Astronomical Observatory of Japan (NAOJ) through an **international partnership with the IAU**, it develops strategic frameworks and international collaborations to strengthen inclusive and culturally informed astronomy communication.

The OAO coordinates the ***Communicating Astronomy with the Public* (CAP) Conference,** the only international meeting dedicated to astronomy communication, and oversees the peer-reviewed ***CAP Journal,*** which supports the advancement of research and professional practice in the field of astronomy communication.

National Outreach Coordinators Network (NOCs)

A network of 400 astronomy communicators from 120 countries, working toguether to diseminate astronomy





Global International public events

Public outreach events like **100 hours of Astronomy** and **Women and Girls in Astronomy**, connecting astronomy with society.

⇒ Asabre, Duran OE-3C, 5C, DW-2C

国立天文台
NAOJ
National Astronomical Observatory of Japan

DIVISION OF SCIENCE
国立天文台 科学研究部
National Astronomical Observatory of Japan
2019–

T. HAMANA

Cosmology

K. KOHRI

Galaxy Formation

M. OUCHI

Cosmic Magnetism

M. MACHIDA

Black Hole

Astrochemistry

J. BABA

J. MORINO

N. HARADA

Active Galactic Nuclei

Star Formation

H. NOMURA

M. DAINOTTI

K. TAKAHASHI

F. NAKAMURA

Protoplanetary Disks

Gamma-ray Burst

K. IWASAKI

E. KOKUBO

Supernova explosion

A. KATAOKA

N. TOMINAGA

T. TAKIWAKI

Planet Formation

T. MORIYA

Exoplanets

M. IKOMA

Y. FUJII

6 full professors (1 from CfCA)
5 associate professors (1 from CfCA, 1 Cross-app.)
8 assistant professors (1 from CfCA)

Unprecedented Capabilities of the TMT

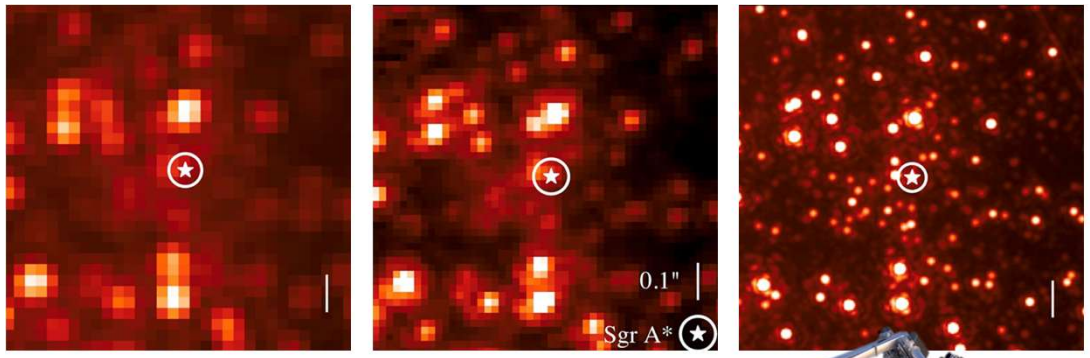
⇒ Aoki PO-7C, Kinugawa, Terada, Yasui, Ozaki PO-14-17P, Noumaru PR-9P

National Astronomical Observatory of Japan

Angular Resolution
Sensitivity

TMT offers exceptional clarity

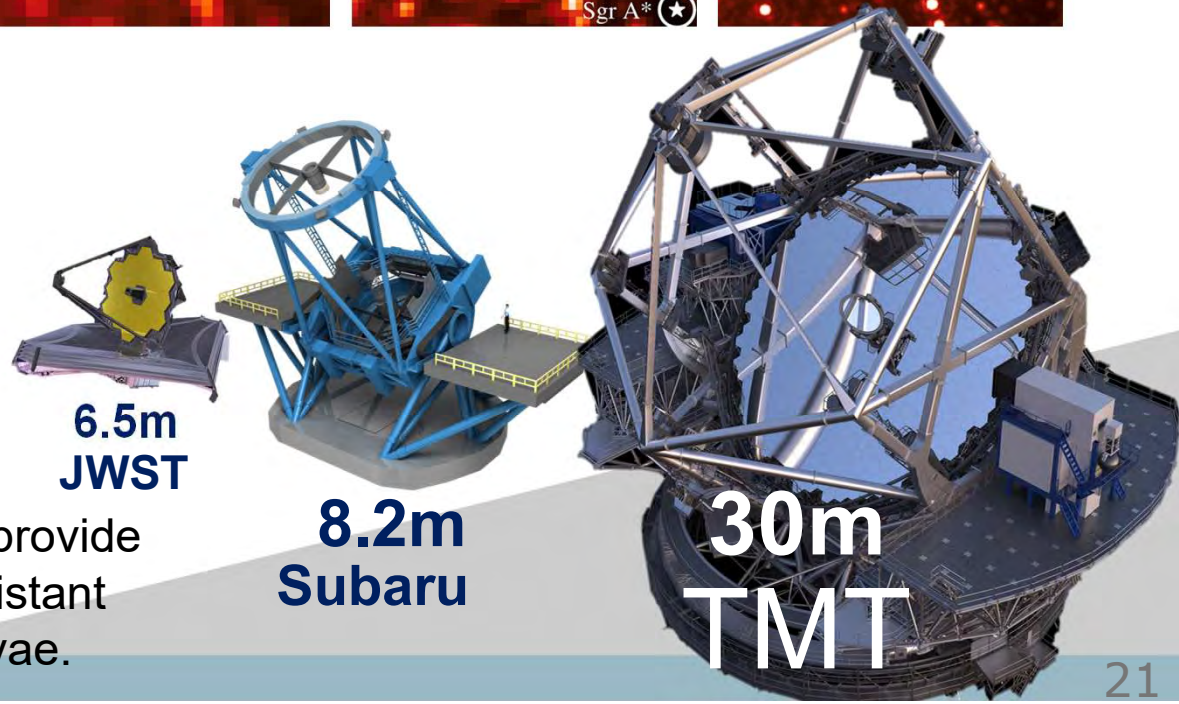
TMT's images are
- ▶ 5x sharper than JWST
- ▶ 3x sharper than 8-10m class telescopes



TMT is extremely sensitive

TMT is
- ▶ 20x more sensitive than JWST
- ▶ 100x more sensitive than 8-10m telescopes

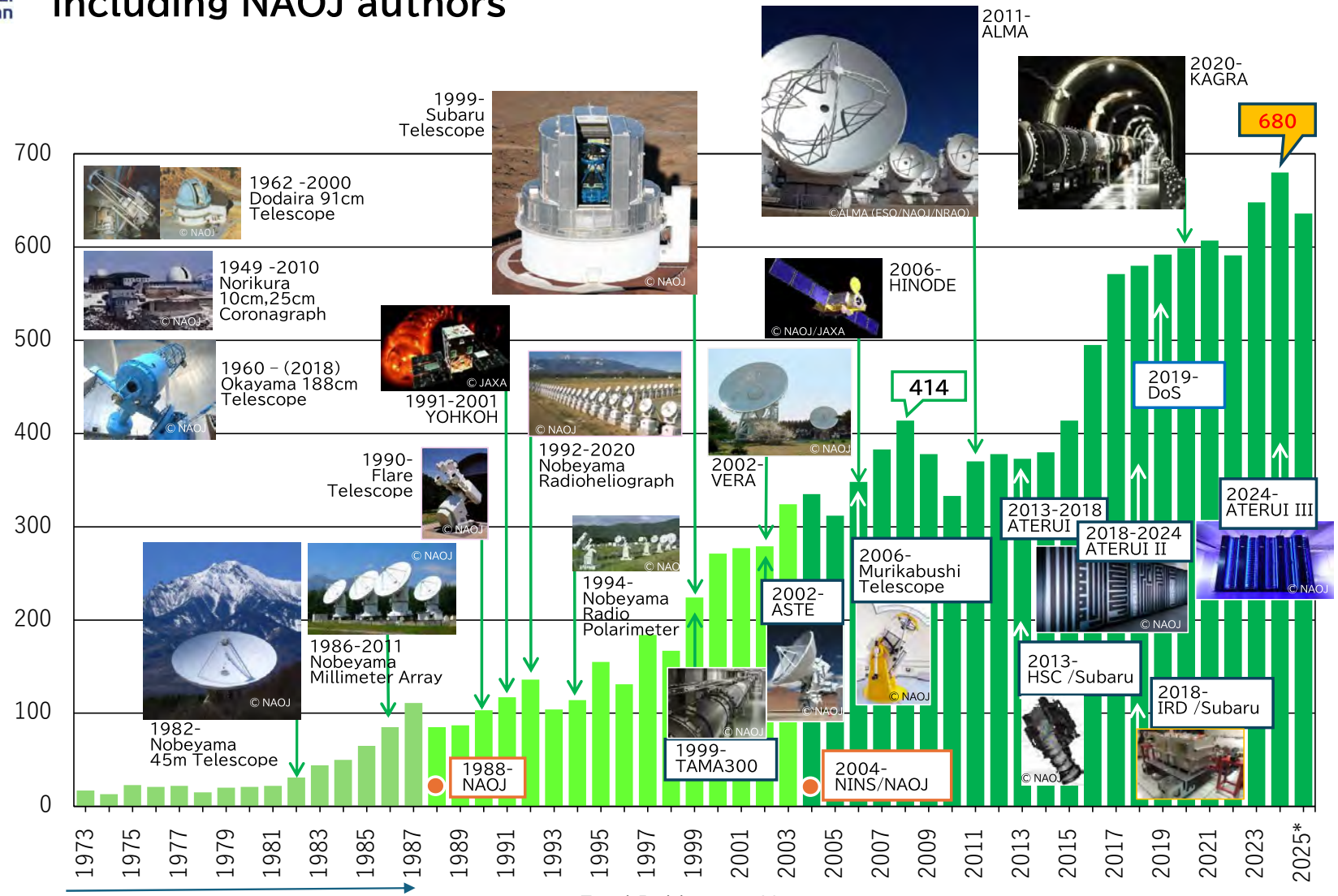
TMT completes a 10-hour Subaru Telescope observation in just 3 minutes.



Japan's strategy

Subaru Telescope's wide-field observations will provide targets for TMT's observations, including most distant galaxies and rare explosive events like supernovae.

Number of Refereed Papers including NAOJ authors

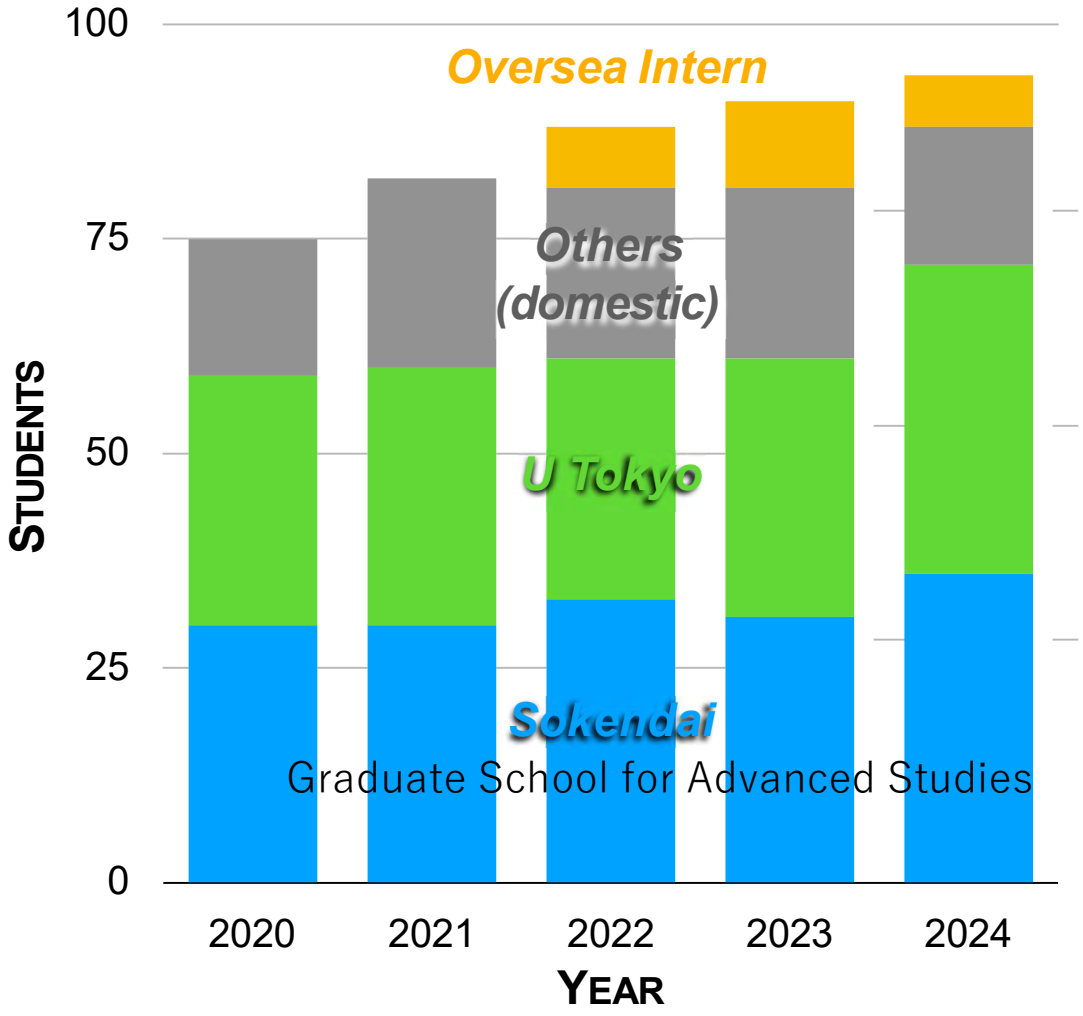


Tokyo Astronomical Observatory, University of Tokyo

Final Publication Year

Source: Web of Science Core Collection
Article & Review Only as of 2025/12/08

Students, Fellows, and visiting researchers



You are very welcome to stay at NAOJ

- Doctoral course for Sokendai (&UTokyo)
- NAOJ oversea Internship

- NAOJ fellowship
- Project Research fellowship
- JSPS international fellowship
- EACOA fellowship

- International Visiting Scholars
- Sabbatical scholars

https://naoj-global.mtk.nao.ac.jp/opportunities/invitational_program_2023.11.10.pdf

Office of International Relations
to support students/staff from foreign countries

EACOA (East Asian Core Observatories)

ASIAA, KASI, NAOC, NAOJ

- There is a discussion to expand EACOA to cover institutes in Asia, such as Thailand, Indonesia, Vietnam, Malaysia, India, …etc., in future.
- Tentative proposal by NAOJ:
  - EACOA to be transformed to a new organization as a group of “core observatories in Asia (not limited to East Asia)” and promote collaborative projects. (The name will be changed, like “ACOA”)
  - Start with
    - Fellowship program
    - Meetings (AMA, AMYA)
  - Member institutes can choose which program they participate in.

Panel Discussion on Friday 1PM-

